New & Emerging Technologies

"We launched the Public Power Institute to acknowledge TVA's role as a steward of the environment and an innovator in our nation's electric utility industry. We chartered the institute to use TVA's integrated power system as a living laboratory and showcase for innovations and solutions."

—Craven Crowell, TVA Chairman

Investment in electricity research and development throughout the electric utility industry is at a 20-year low. However, the energy requirements of the estimated world population of ten billion people in the year 2050 will be immense and varied, and today's technology will be inadequate to meet future demand while also meeting the environmental requirements of the 21st century. In response to this challenge, TVA created the Public Power Institute, whose mission is "Bringing together new ideas and technologies to support public power's roles as a power producer, leader in environmental responsibility, and promoter of efficient energy use."

Public Power Institute

The Public Power Institute (PPI) is designed to serve TVA and the broader energy community as a means for achieving advancements in energy production and delivery and end-use energy efficiency, in concert with protecting and sustaining the environment. PPI will complement and enhance TVA's role in developing technologies and addressing national issues of air quality, renewable energy supply, and efficient energy production and use.

PPI focuses on technology research, development, demonstration, and deployment in four areas: Environmental Impacts and Reduction, Clean and Advanced Energy, Biomass and Renewables, and Energy Use and Industrial Ecology. Over the past year, PPI demonstrated and deployed innovative new products and ideas in each of these technology areas, including Regenesys, microturbines, green power, and biomass co-firing.

Regenesys™

In November 2000, the TVA Board approved a contract with Innogy Technology Ventures Limited of the United Kingdom to build an innovative, first-of-its-kind power plant in the U.S. using the technology known as "Regenesys." This method stores electricity during periods of low-power demand and transmits electricity during times of peak demand.

Specifically, the Regenesys plant stores or releases electrical energy by means of a reversible electrochemical reaction between two salt solutions, called "electrolytes." The electrolytes are pumped through individual cells separated by a membrane. Hundreds of cells are in the flow battery, where the energy is stored. The cells are connected electrically and hydraulically, but they function individually. The electrolytes used in the process are stored in two large external tanks. The concentrated solutions are sodium bromide and sodium polysulphide—both readily soluble. Neither presents adverse hazards in handling or storage. When storing energy, the electrolytes convert to a charged state and then are discharged to release energy. The conversion of electrical to stored chemical energy can be repeated indefinitely and with high efficiency.

TVA's goal for this project is to improve system reliability, reduce momentary supply interruptions, and maintain peak-demand voltage levels, while simultaneously having a minute impact on the environment. The entire system requires about two acres and can be located near an existing substation, with the plant being about the size of a four-story office building. This helps to reduce the need to build additional power lines and lessens the environmental impact of building a power plant.

Microturbines

Microturbines are part of a breed of newly emerging technologies to be used for distributed generation applications. They are being promoted for their ability to provide power and useful waste heat at or near the location where energy is consumed, either supplementing or replacing grid-delivered power. Applications for this new technology include providing the customer with stand-alone baseload, peaking, or standby/emergency power, or recovering and converting low energy waste gases into useful power generation.

Several developers are either in the final product development stages or beginning to introduce their microturbine products into the marketplace. The Capstone Corporation is marketing a 30-kW microturbine system which is fueled by natural gas and has a combustion turbine/generator rotor which spins while suspended on air bearings. The system uses no oil or water lubricants or coolants and is said to have very minimal maintenance requirements. The Honeywell Corporation has developed a 75-kW microturbine system, marketed as the Parallon 75, which is similar to the Capstone system. Other microturbine developers who are expected to have commercially available products shortly include Northern Research and Engineering, Bowman Power Systems, and Elliot Energy Systems.

With fewer moving parts than conventional natural gas and diesel-fueled reciprocating engines, microturbines are expected to have lower maintenance costs than the generator sets commonly purchased and currently used for standby/emergency on-site generation. Another advantage of this technology over conventional diesel generation is that it is much cleaner, with very low NO_X emissions. However, operational efficiencies of microturbines are only around 30 percent resulting in a higher fuel cost per unit of energy generated than conventional reciprocating engine technologies. The Department of Energy recognizes the potential

of this technology and is sponsoring research to increase the efficiencies of microturbines to near 40 percent.

TVA is sponsoring tests to evaluate microturbine technologies on the basis of performance, reliability, emissions, noise, and other factors as well as the economics associated with the purchase and operation of these units. TVA installed a 30-kW Capstone microturbine at the PPI building in Muscle Shoals, Alabama, in 2000, and is operating the unit to power selected loads within the building while evaluating its performance. A similar test is planned for 2001 with a Honeywell Parallon 75, which will be tested by PPI and Huntsville Utilities Board (HUB) as it is used to provide supplementary power for HUB's Operations Center at Chase Industrial Park.

As a result of their high initial costs and moderate operational efficiencies, microturbines are not expected to be economically competitive versus grid-supplied power in the TVA region for some time. However, they are beginning to find niche applications throughout the nation, and expected cost reductions and improvements in the technology mean that microturbines may be widely used in the future.

*Green Power Switch*SM

Green Power SwitchSM, designed by representatives from TVA, distributors of TVA power, and the environmental community, is a renewable energy initiative that offers consumers in the Tennessee Valley a choice in the type of power they buy. Several public power companies in the TVA service area are selling energy generated by solar, wind, and landfill gas resources in a year-long market test that began in April of 2000. It is the first green power program of its kind in the Southeast and provides customers the option of paying a small premium to ensure that a portion of their electricity comes from non-polluting, renewable energy sources. The program was developed by PPI and implemented by TVA's Customer Service and Marketing group.

To provide power for the program, TVA constructed solar sites and wind turbines and is negotiating with landfill operators. Several solar sites are located at public schools and science museums, with at least one to be located at a baseball stadium at the University of Mississippi. Construction is complete on solar collectors at Cumberland Science Museum in Nashville, Tennessee; Ijams Nature Center in Knoxville, Tennessee; Sci-Quest Museum in Huntsville, Alabama; and tram stops at the Dollywood theme park in Pigeon Forge, Tennessee. The first wind turbines were erected on the site of a reclaimed coal strip mine on Buffalo Mountain in Anderson County, Tennessee, and were operational in October 2000. The biggest component of the current green power mix will be the electricity powered by landfill gases.

The Green Power Switch program received national attention during a press briefing at the National Press Club in Washington, D.C., when the Center for Resource Solutions announced that TVA and the distributors of TVA power participating in the Green Power Switch were one of the first groups to receive national accreditation of their program. This third-party accreditation provides assurance to consumers that the renewable sources used to generate the power for the program meet certain standards and that the amount of green power sold does not exceed that which was generated.

Biomass Co-firing

In addition to the power produced from wind turbines, solar panels, and landfill gas, co-firing introduces another shade of green to the generation mix in the Tennessee Valley. This technology makes the most of a pre-existing investment in coal plants by using waste products bound for already bloated landfills, providing environmental benefits that can be realized in the near term.

TVA began conducting tests incorporating biomass into its coal-fired power plants in the 1990s. Initial engineering studies demonstrated the environmental and economic benefits of co-firing. TVA selected three coal-fired power plants for testing: Allen Fossil Plant in Memphis, Tennessee; Kingston Fossil Plant near Oak Ridge, Tennessee; and Colbert Fossil Plant in Cherokee, Alabama.

At Allen Fossil Plant, TVA mixed coal with up to 20 percent wood fibers successfully. In addition to adding wood, TVA successfully added shredded tires to the fuel mix, which could prevent used tires from being buried in landfills.

Commercial co-firing is currently being done at the Colbert Fossil Plant using wood waste from a local furniture factory. Co-firing four percent wood blended with coal resulted in removing wood waste that would have been sent to landfills, reducing the environmental impact. TVA found that wood wastes could be co-fired in a 192-MW wall-fired unit with no significant impact on boiler efficiency, and low-level co-firing of the wood waste reduced some plant emissions. This project also discovered a low-cost, highly effective wood system could be built that will deliver wood wastes equal to or less than one-quarter of an inch onto the 700 ton per hour coal feed belt.

Commercialization of wood waste co-firing at Colbert Fossil Plant has provided benefits in the area of fuel diversity and fuel cost management, customer service, and the ability to initiate programs associated with portfolio standards and the generation of renewable energy. TVA is exploring many ways to use biomass for bio-based products and energy, including biomass gasification.